

CE2 Engineers, Inc.

Haines Borough Wood Heat Feasibility Study

[An analysis prepared for the Haines Borough to explore the viability of a woody-biomass-fired district heating system of Borough buildings.]

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1.0 EXECUTIVE SUMMARY

The following assessment was commissioned by the Haines Borough to determine the viability of biomass energy integration at Borough and school buildings in Haines, Alaska. The goal was to lower heating costs for Borough buildings. The four buildings include the Haines Borough Administration building, Haines Public Library, Haines School, and Haines School Vocational Education Building. A fifth building, the Sewage Treatment Plant, was added as an option to see if it would be economic to include it in the proposed central heating plan.

Fuel resource, quality and infrastructure are all critical to the sustainability of biomass energy and must be considered carefully before proceeding with a project. Although this assessment is preliminary in nature and the results must be verified at time of project implementation, it appears that the fuel resource and infrastructure near Haines are adequate to supply biomass fuel to the project. After researching the local wood sources and consulting with State Forester Greg Palmieri, it is apparent that the forest resource, knowledge, infrastructure, and desire exist to make the fuel supply a reality. Pellet manufacturing doesn't exist in Southeast Alaska; however several manufacturers exist in British Columbia and the Pacific Northwest of the lower 48 that would be capable of providing fuel. In addition, a new wood pellet plant is coming on line in Fairbanks, and utilizing sawmill waste by manufacturing wood pellets in Craig, Alaska is being seriously considered for the Southeast Alaska market.

Air emissions associated with biomass energy need to be addressed very early in the design process. An overview of the factors and recommended approach to air quality permitting is provided in the appendix of this report. This overview was developed by a nationally recognized environmental engineering firm specifically for this assessment. It was found that the emissions from a proposed woody-biomass plant would be similar to that of the existing fuel oil used presently for heating. Particulate matter emissions (PM10 and PM2.5), which can affect people with respiratory problems, can be reduced to very low levels with the use of electrostatic precipitators.

The metrics of feasibility for this assessment include technical feasibility, the net present value of each project option, and other extenuating factors that were identified during the course of assessment.

The following table summarizes the economic analysis for base options considered.

Table 1 — Economics Summary

| Option | Project Cost | Year 1 Operating Savings | NPV 30 yr at 3% | NPV 20 yr at 3% | ACF YR 30 | YR ACF=PC |
|--|--------------|--------------------------|-----------------|-----------------|-------------|-----------|
| Option A.1A Main Campus | \$2,673,000 | \$22,821 | \$2,335,846 | \$1,116,128 | \$4,274,093 | 25 |
| Option A.1.B Campus and Boiler Plant Location B | \$2,770,000 | \$22,821 | \$2,335,846 | \$1,116,128 | \$4,274,093 | 26 |
| Option A.1.C Adding Sewer Plant to Campus and Boiler Plant Location C | \$3,196,000 | \$17,710 | \$2,284,993 | \$1,055,333 | \$4,218,911 | 27 |
| Option A.2A Campus Less Vocational Education | \$2,549,000 | \$21,621 | \$2,250,020 | \$1,072,870 | \$4,119,428 | 25 |
| Option A.3A School Building Only Less Vocational Education | \$2,289,000 | \$17,098 | \$1,926,455 | \$909,790 | \$3,536,340 | 26 |
| Option A.4A Adding A Larger Load Such as DOT to Campus | \$3,196,000 | \$30,570 | \$3,204,906 | \$1,518,980 | \$5,876,662 | 24 |
| Option B.1 Campus with Pellet Boiler and Boiler Plant Location A | \$2,258,000 | -\$25,562 | \$926,646 | \$176,661 | \$1,972,273 | >30 |

Conclusion

With the present fuel oil price per gallon, consumption of fuel oil, and the high capital costs of integrating a biomass heating system into multiple boiler rooms, this project is challenged.

Currently the 30 year NPV of the annual savings does not equal the initial project cost and the ACF equals the 30 year NPV in year 25. The project economics are greatly affected by fuel oil cost and inflation. If fuel oil approaches \$3.75 per gallon, or the long term fuel oil cost inflation rate approaches 8% (as opposed to 6%), then the project becomes much more viable. If additional fuel oil loads can be added to the system (for a total displacement of at least 65,000 gallons) with reasonable integration costs, the project becomes more viable. Recent projects in the western continental US of similar scope of integration have had better economics. This is mainly due to the fact that the cost of construction is less in the lower 48 (nearly 30%), and also because chipped wood fuel can be purchased between \$40 and \$60 per ton.

2.0 OVERVIEW OF BIOMASS AND THIS STUDY

This feasibility study was commissioned by the Haines Borough to determine the viability of a woody biomass-fired central heating system for certain Borough-owned buildings in downtown Haines.

Economics of alternatives for the use of woody-biomass to displace 90% of the fuel oil used for the Borough Administration Building, Library, School, and Vocational Education Building.

- Possible wood fuel sources, their economics, environmental, and social factors with their use
- Existing mechanical systems, and how they would be integrated into the new heating system
- Building and site constraints that affect the design of a new woody biomass-fired heating system
- Air quality issues that need to be addressed with the use of a woody biomass-fired heating system
- Types of different biomass heating systems and layouts that could be used in Haines
- Evaluation of the three proposed alternative systems, with an option of tying the existing sewage treatment plant into the central heating system.

The results of this study would be a conceptual design of the biomass heating system, along with a capital cost estimate for the selected alternative.

Once the Haines Borough has this information, it can then make an informed decision whether or not to go on to the next step and develop the design of the system for eventual construction, when funding permits.

2.1 Potential of Biomass Energy Systems

Biomass energy systems hold great potential to reduce energy costs, derive energy from local sources, and reduce the net carbon footprint for certain projects while playing a role in active forest management. That said, implementation of biomass energy has a set of complexities that are important to consider in every project. Failure to satisfy any one or more of these issues may result in a project of marginal success, or outright failure. This set of preliminary assessments

attempts to address the feasibility of implementing biomass in biomass energy integration at Borough and school buildings in Haines, Alaska. For every biomass project considered, an objective approach to addressing the following points is required:

- **Fuel resource.** Adequate fuel resources must exist in a reasonably local manner. In Southeast Alaska, this means that fuel must be logistically feasible to procure for a reasonable cost. For all projects considered, the fuel resource can be accessed by either truck from selected sources or ocean transport for Southeast Alaska island sources. Fuel logistics will involve bulk truck or barge delivery / stock-pile of fuel, or pre-conditioned fuel delivered in shipping containers. Chip fuel for these projects is likely to be derived from Southeast Alaska providers. Pellet fuels can only be accessed from British Columbia, the Pacific Northwest of the Lower 48 States at this time, though a Fairbanks pellet plant is presently under completion and startup. Specific fuel resource issues are discussed in the option assessments.
- **Site technical requirements.** Site requirements include:
 1. Logistics of fuel delivery. Trucks, typically 40 ft. chip tractor-trailers or trailer mounted shipping containers need to be able to access the site easily.
 2. Type of existing mechanical system and the complexity of biomass integrating to this system.
 3. Space requirements to implement a biomass energy plant. These systems are space intensive and are difficult to implement on some constrained sites.
- **Air Quality and Emissions Permitting.** Although modern biomass systems are clean burning and capable of meeting the vast majority of air quality permitting requirements, permitting requirements must always be checked early in the project assessment process. Refer to Section 6 Air Quality Issues for a discussion.
- **Economic Criteria:** The economics of biomass are quite dependent on the displacement of a significant amount of fossil fuel energy. The definition of a “significant amount” of fuel varies depends on the cost of that fuel and the counterbalancing cost of project implementation.
 1. The cost of energy is critical as well. Propane and fuel oil offer the best economics, but in many areas of the country, natural gas displacement can offer

adequate economic leverage to make projects work. All existing boilers in this assessment are fuel oil based.

2. The cost of biomass fuel varies on location, available infrastructure, and type of fuel.
 3. Biomass systems require additional maintenance compared to most systems. This cost is usually small compared to savings, but must be considered in the course of assessment.
- **Operation and Maintenance Requirements.** The type of biomass system must match the existing, or reasonable expansion of, the facilities maintenance staff's capabilities. System maintenance requirements vary greatly in complexity and need to be matched to each situation carefully. The Borough has competent and capable maintenance staff.
 - **Project Owner and Staff project support.** Biomass implementation is capital intensive and requires physical modification to the facility and its site. The support of the leadership of the affected buildings is critical to a successful project.

2.2 Biomass System Types/Primer

Biomass projects take several different forms. For purposes of this assessment, the technologies will be categorized as green chip or pellet. A detailed primer discussing these technologies is available online at: <http://www.fleci.org/docs/WhereWoodWorks-Online.pdf>, and is also available in Appendix E.

3.0 WOOD FUEL SOURCE

3.1 Fuel Quality

The success of all biomass projects is very dependent upon the quality of fuel that is used in the plant. Many sources of biomass exist in Alaska and the West and the quality varies widely. Often inexpensive and possibly free fuels are used in heating plants, causing inadequate performance from the plant in terms of energy and emissions output and dramatically increased maintenance and repair expense. The poor performance is often incorrectly placed on the heating plant equipment.

It is imperative that the quality of the fuel be maintained as a standard. This fuel also may be processed by either chipping or grinding. Generally the minimum fuel quality is expected to be derived from chipped or ground whole trees. The following guidance is provided for specifying fuel quality.

3.1.1 Whole Tree Fuel Specification Points (Southeast Alaska):

- Target Moisture Content 40% after drying
- Minimum Btu's/lb (wet weight) 4,500 (HHV)
- Target Chip Size 2" x 2" x 1/4" (Local infrastructure specific)
- A maximum of 10% shall be 4 inches or larger in any dimension
- A maximum of 10% shall be smaller than 1/16"
- Minimal wood flour or dust is allowed.
- Total Ash Content Maximum 8% (dry matter basis)
- Alkali Mineral Content of Ash Maximum 0.3 lbs/MMBtu

The likely forest resource is a mix of spruce, hemlock, and cedar, with hemlock being the preferred species. A primary concern with fuel supply in Southeast Alaska is management of the fuel's moisture content. The higher the moisture, the more of the woody-biomass it takes to drive off the moisture in the fuel, and the less useful heat is available. At the time of processing,

chipped product is at 58% moisture content at one Southeast operation. This fuel will dry to about 20% less than that if stored and aerated once or twice in a covered environment. It will be imperative that all fuel suppliers be required to shelter fuel supply from rain and develop processes to deliver fuel that meets the above specification. In addition to moisture content control before delivery, it is recommended that provision for in-plant drying systems be designed for all chip plants in Southeast Alaska.

Material should be aged in the landing for 3-12 months in whole tree piles. Tree felling, skidding, and fuel processing methods should minimize introduction of dirt and rocks. Fuel should be processed directly into the sheltered cover at the time of chipping. If fuel is ground, the fuel should be double ground and sized. It is imperative that the biomass system supplier understand that ground fuel may be used in the plant as material handling for ground fuel can be significantly different than that for chipped-fuel-only plants. Fuel needs to be free of all foreign materials such as rocks, soil, ice, paint, glue, etc.

In Appendix A, different possible sources of woody biomass were examined. The sources were:

- Wood chips derived from timber in the Haines State Forest
- Wood chips delivered to Haines from the Dimok Timber mill, near Haines Junction, Yukon Territory, Canada
- Wood chips derived from sawmill slabs from Tok sawmills
- Wood chips (sawdust) from Viking Lumber sawmill, near Craig, Alaska.
- Wood pellets from various sources ranging from the Pacific Northwest, western Canada, and Alaska.

From the wood source study, it appears that utilizing wood chips derived from timber in the Haines State Forest was a viable option. In addition, for the purposes of this study, wood chips from this source were expected to be 50% moisture on average, wet basis.

4.0 EXISTING BOILER SYSTEMS AND FUEL OIL USE

The four buildings that were investigated are the Haines Borough Administration building, Haines Public Library, Haines School, and Haines School Vocational Education Building. An optional fifth building was examined and that was the Sewage Treatment Plant. All the buildings, except the Sewage Treatment Plant utilize fuel oil fired hot water boilers for the building heat. The Sewage Treatment Plant has three fuel oil fired furnaces to heat the building. A summary of the annual fuel oil use and boiler output sizes is shown in the following tables:

| Table 2 — Fuel Oil Use Summary | | | |
|---------------------------------------|------------------------|--------|-------------------|
| Building | Fuel Oil Use - Average | | |
| | Gallons | \$/Gal | Cost |
| School | 36,414 | \$2.87 | \$ 104,508 |
| Vocational Education | 1,200 | \$2.87 | \$ 3,444 |
| Administration | 1,221 | \$2.87 | \$ 3,504 |
| Library | 3,303 | \$2.87 | \$ 9,480 |
| Sewer Treatment Plant | 7,000 | \$2.87 | \$ 20,090 |
| Total | 49,138 | | \$ 120,936 |
| Total less Sewage Plant | 42,138 | | \$ 100,846 |
| Total less Sewage Plant and Voc. Ed. | 40,938 | | \$ 97,402 |
| Administration & Library Total | 4,524 | | \$ 12,984 |

| Table 3 — Connected Boiler Load Summary | | | | |
|---|-----------|---------------|------------------------|----------------------------|
| | | Output MBH | Peak Load Factor | Likely Sys. Peak MBH |
| School | Boiler 1 | 1632 | 0.67 | 1093 |
| | Boiler 2 | 1632 | 0.67 | 1093 |
| | Boiler 3 | 1632 | 0.67 | 1093 |
| School Total | | 4896 | | 3280 |
| | | | | |
| Vocational Education | Boiler | 219 | 1.0 | 219 |
| | | | | |
| Administration | Boiler | 133 | 1.0 | 133 |
| | | | | |
| Library | Boiler 1 | 515 | 0.7 | 361 |
| | Boiler 2 | 515 | 0.7 | 361 |
| Library Total | | 1030 | | 721 |
| | | | | |
| Main Campus Total | | 6278 | | 4353 |
| | | | | |
| Main Campus Total less Voc. Ed. | | 6059 | | 4134 |
| | | | | |
| Administration and Library Total | | 1163 | | 854 |
| | | | | |
| Sewage Treatment Plant | Furnace 1 | 87 | 1.00 | 87 |
| | Furnace 2 | 250 | 1.00 | 250 |
| | Furnace 3 | 250 | 1.00 | 250 |
| Sewage Treatment Plant Total | | 587 | | 587 |
| | | | | |
| Campus Total Plus Sewage Treatment Plant | | 6865 | | 4940 |

All existing boiler systems were preliminarily investigated for integration of a secondary heat supply (districted biomass). In all cases, integration to the boilers with a de-coupled loop appears possible. This approach allows the existing boiler plants to operate as decentralized redundancy, backing up a new central biomass plant districted to the listed facilities. Other facilities may be added to a district system. The scope of extension used for this analysis was limited to the above buildings, extension to addition loads can be incrementally assessed as they would likely have minimal effect on the infrastructure “backbone” analyzed herein.

4.1 Biomass Boiler Size

Unless the facility has a constant heating load throughout the year, sizing the biomass boiler at the peak heating load is not recommended. Biomass boilers do not modulate down well, and do not operate at peak efficiency at low loads. We recommend sizing the biomass boiler to offset approximately 90% of the annual heating energy use of a building or facility. The existing heating systems would be used for the other 10% of the time during peak heating conditions and when the biomass boiler is down for servicing. Recent energy models of similar buildings have found that a boiler sized at 50% to 60% of the building peak load will handle approximately 90% of the boiler run hours. The following table summarizes the likely peak loads for each building and then factors in the biomass boiler factor of 0.6 to estimate the likely biomass size that would supplant approximately 90% of the heat energy. The table also shows the estimated required flow rate to distribute the heat to each building and the corresponding required pipe size.

Table 4 — Proposed Biomass Boiler Size

| | | | | Likely System Peak MBH | Biomass Boiler Factor | Biomass Boiler Size MBH | Flow Rate at 30° dT GPM | Estimated Pipe Size |
|---|--|--|--|---------------------------------|-----------------------------|----------------------------------|----------------------------------|---------------------------|
| School | | | | 3280 | 0.6 | 1968 | 131 | 4" |
| Voc. Ed | | | | 219 | 0.6 | 131 | 9 | 1-1/2" |
| Administration | | | | 133 | 0.6 | 80 | 5 | 1" |
| Library | | | | 721 | 0.6 | 433 | 29 | 2-1/2" |
| Sewer Treatment Plant | | | | 587 | 0.6 | 352 | 23 | 2-1/2" |
| Proposed Campus Total | | | | 4353 | | 2612 | 174 | 4" |
| Proposed Campus Total Less Voc. Ed | | | | 4134 | | 2481 | 165 | 4" |
| Administration & Library Total | | | | 854 | | 512 | 34 | 2-1/2" |
| Proposed Campus Plus Sewer Plant | | | | 4940 | | 2964 | 198 | 4" |

For this assessment the boiler size that meets this criterion for the entire campus (less the Sewage Treatment Plant) would be approximately 2,600,000 Btu/hr.

5.0 BUILDING AND SITE CONSTRAINTS

The central wood-chip-fired heating plant has site requirements for its successful, economic, safe and aesthetic operation. These requirements are:

1. A central location to minimize pipe runs to buildings. Long pipe runs mean higher capital costs, higher operating costs because of increased pumping requirements, and additional heat losses.
2. A boiler building location that will provide easy access for chip trucks to deliver product to the chip bin in the boiler building. It should be relatively easy for the trucks to deliver their product in an area of low traffic, both in vehicles and people.
3. Building location should be close the school building, if possible, because that is where the bulk of the heat load is located.
4. The building should be far enough away from the school complex so as not to be a hazard or an attractive nuisance to children.
5. Consideration must be made for the inclusion of an exhaust stack of up to 50-ft high for proper dissipation of exhaust gasses. Air quality, as well as aesthetics must be considered in the placement of this stack.
6. The building should be located so as not to be an aesthetic detriment to the downtown area. It is an industrial building, so its placement should be carefully considered, so as not to detract from the character of area.

The Haines Borough owns the land where the boiler building and piping would be located, so that site control for these improvements is not a concern. However if the boiler building is located across the main State highway, say near the Sewage Treatment Plant, then additional expenses and effort will be needed to permit and horizontally bore for heat pipe crossing the highway.

Alternative layouts for the central heating system are shown in Figures 4, 5, and 6 in Section 11.

6.0 AIR QUALITY ISSUES

Air quality is an important consideration in using woody biomass-fired heating systems. We want to keep the amount of harmful emissions below the levels currently set by EPA, and below what we can reasonably expect will be future levels set by EPA. Retrofitting pollution control equipment can be problematic and expensive, so anticipating future requirements is a prudent thing to do.

Resource Systems Group of White River Junction, Vermont, was tasked with assessing air quality issues for a proposed central wood chip-fired boiler system at Haines. Their technical memorandum is found in Appendix B.

Before replacing 90% of fuel oil with wood chips, it is important to see the effect on emissions. Figure 1 below shows a comparison of wood and No. 2 fuel oil emissions for selected pollutants.

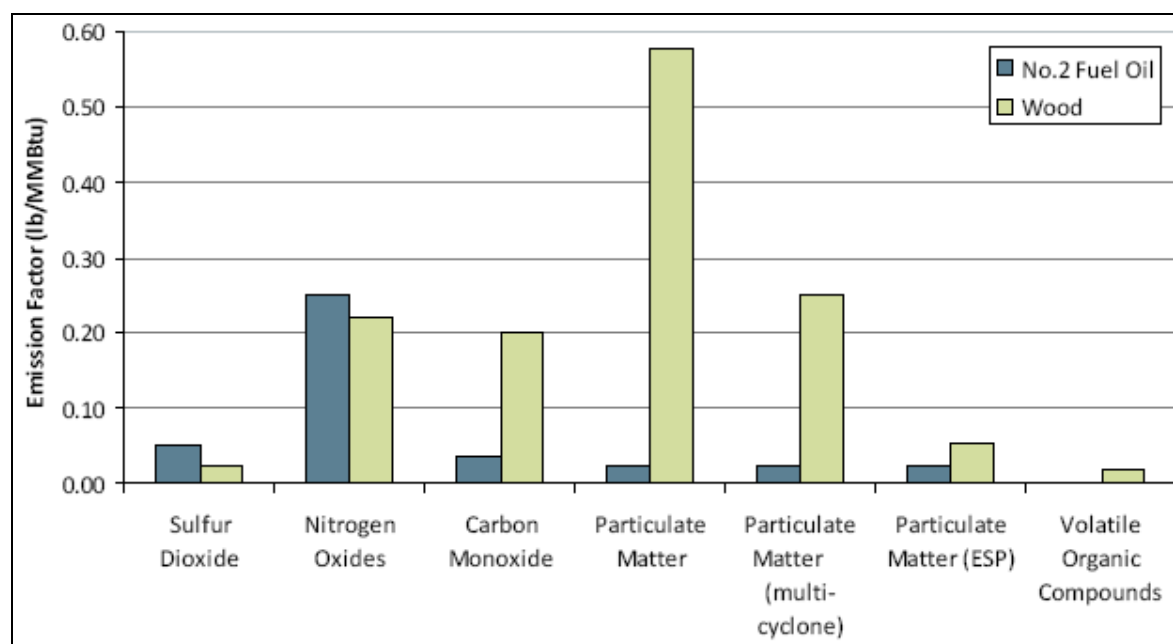


Figure 1 — Wood and No. 2 Fuel Oil Emissions

Note that emissions are similar between the two fuels except for carbon monoxide and particulate matter, which have levels higher than that of fuel oil. Carbon monoxide levels are low, but can be minimized by careful tuning of the combustion process at the wood boiler. Levels of particulate matter, especially PM 10 (particulate matter less than 10 micron size) are of

serious concern because they can produce respiratory problems, especially in young children and adults with respiratory problems, such as asthma. The higher levels of PM10 can be brought down to similar levels as that of fuel oil by use of an ESP (electrostatic precipitator) in the exhaust stream between the boiler outlet and the stack. Note the low level of PM10 in the bar graph that is similar to that of fuel oil by use of an ESP.

We will assume a heat output of 6.5 million BTU/hr (MMBTU/hr), 50% moisture in the wood chips from local hemlock, bole wood chips with bark, and a boiler efficiency of 65%. Heat input would be

$$(6.5 \text{ million BTU/hr}) / 0.65 \text{ efficiency} = 10 \text{ million BTU/hr input.}$$

This is about 2.5 times what is projected in this study for Haines. The amount of annual emissions at this level will be examined, and compared as to what is allowed by current regulations. For State permit thresholds, a minor source permit must be considered for systems whose design heat output exceeds 350,000 BTU/hr. Table 5 below from the technical memorandum shows the emission thresholds for various pollutants:

Table 5 — Expected Emission Levels for Burning of 6,500 Tons of Woody Biomass

| Pollutant | Permit Threshold (tons/year) | Estimated Uncontrolled Emissions (tons/year) | Percent of Permit Threshold |
|--|------------------------------|--|-----------------------------|
| NOx (nitrogen oxides) | 40 | 5.8 | 14% |
| SO2 (sulfur dioxide) | 40 | 0.7 | 2% |
| CO (carbon monoxide) | 100 | 15.8 | 16% |
| PM10 (particulate matter < 10 microns) | 15 | 15.1 | 101% |
| Lead | 0.6 | 0.0 | 0% |

The level of estimated uncontrolled emissions for all pollutants is less than 16% of the permit threshold, with the exception of PM10, which is right at the threshold. The actual amount of wood chips burned would be about 800 tons/6500 tons x 100 = 12.3%, so technically, an ESP added to the exhaust stream would not be required. However, it would be prudent to add it now,

as there is a high likelihood that this pollutant will be more strictly controlled by EPA in the future. All other pollutants listed would not require additional emissions controls.

An exhaust stack approximately 2.5 times the building height would be recommended, so that the exhaust stream is smoothly dissipated without being driven down on nearby buildings and areas. This would need to be further investigated during design, but for preliminary planning, the exhaust stack should be about 50-ft tall.

At present, it does not appear that Haines is subject to inversion, PM10, and PM2.5 pollution issues of the type experienced in Juneau. However, this should be further explored in the design phase.

7.0 BIOMASS SYSTEM OPTIONS

Six wood chip boiler options were analyzed along with one wood pellet boiler option. The wood chip boiler options were divided by boiler plant location. See the Building and Site Constraints section for further discussion on the different boiler plant site locations.

For all options a stand-alone boiler plant was assumed (see Figures 2 and 3 in Section 11). The plant concept is a slab on grade building with concrete walls up to 4'-0" to allow for a solid durable surface to push chips against. The remaining portion of the building would be a metal building system. Chips would be on one side of the plant and the concept is for a chip van (40 ft trailer) with a live bottom floor to back into the chip storage side and slowly pull out as the chips unload. Approximately 30 tons of chips could be stored. On average, it is estimated one delivery per week would be needed, however, during peak heating periods two to three deliveries per week may be required.

A travelling auger would run near the floor of the chip storage and pull the chips onto a conveyor which would then elevate and fill a metering bin. Because the chips are anticipated to be around the 50% MC range, the concept would be for a small air handling unit to blow warm air through an enlarged metering bin to handle any chip drying that would be required. The main heating water system pumps and associated air separator and expansion tank would also be located in the boiler plant. The current concept is to isolate the district system with the existing building systems. This will require a heat exchanger and injection pump in each boiler room. The main reason to isolate the district system is for redundancy. If all the systems are piped together and a catastrophic leak happens in the district piping, all the building systems would drain and all heating would be lost at the buildings. Isolating the systems allows the existing heating systems to heat the buildings in the case of a problem with the district piping.

The installation of a green chip heating plant is a capital-intensive endeavor. Maximizing the load connected to the capital investment is a sound strategy to optimize the economics. For this project it means the installation of an extensive district heating system as described in the Building and Site Constraints portion of this report. A district piping concept was developed to

arrive at cost information for this assessment. The following are the options explored in this assessment.

7.1 Wood Fired Boiler Options

Option A.1A

The boiler plant is located in location A (see Figure 4 in Section 11), and district piping interconnects with the Borough Administration building, the Public Library, the School, and the Vocational Education building.

Option A.2A

The boiler plant is located in location A (see Figure 4 in Section 11), and district piping interconnects with the Borough Administration building, the Public Library, and the School only – no connection to the Vocational Education building.

Option A.3A

The boiler plant is located in location A (see Figure 4 in Section 11), and district piping interconnects with the School only – no connection to the Vocational Education building.

Option A.4A

The boiler plant is located in location A, and district piping interconnects with the Borough Administration building, the Public Library, the School, the Vocational Education building, and some other high fuel use facility (perhaps DOT). This option was not developed in great detail, but was established to determine the effect of adding a larger load to a campus system.

Option A.1B

The boiler plant is located in location B (see Figure 5 in Section 11), and district piping interconnects with the Borough Administration building, the Public Library, the School, and the Vocational Education building.

Option A.1C

The boiler plant is located in location C (see Figure 6 in Section 11), and district piping interconnects with the Borough Administration building, the Public Library, the School, the Vocational Education building, and the Sewer Treatment Plant. The costs for this option include adding new piping through the plant and replacing the fuel oil furnaces with hot water unit heaters.

WOOD PELLET BOILER OPTIONOption B.1

The boiler plant is located in location A (see Figure 4 in Section 11), and district piping interconnects with the Borough Administration building, the Public Library, the School, and the Vocational Education building. The boiler plant is half the size of a pellet plant because chip storage is no longer necessary. An exterior pellet silo would be utilized for this option.

CORDWOOD-FIRED HEATING SYSTEM OPTION

Because of the relatively large connected load of the proposed plant, the anticipated high volume of wood fuel used, and the high level of labor required to supply fuel and tend to the heating units, the cordwood-fired heating system option was not pursued.

8.0 COST ESTIMATE AND ECONOMIC ASSUMPTIONS

8.1 Cost Estimate

The cost estimates are at a preliminary design level and are based on RS Means and bid data from recent biomass projects. The estimates are shown in Appendix C. The estimates assume the new biomass boiler system heating water loop is isolated from each building with heat exchangers and also assumes a small chip drying air handler will be installed in the boiler plant. The estimates also include a live bottom chip van into the total project cost.

8.2 Fuel Displacement

For the purpose of this investigation it is assumed that 90% of the existing annual fuel oil consumption could be offset by the use of wood chip fired boiler.

8.3 Wood Fuel Costs

The cost of wood chips was assumed to be \$85/ton (see fuel resource inventory portion of this report). The biomass boiler efficiency was assumed to be 70%. The wood chips were assumed to be Hemlock at approximately 50% moisture content, yielding a heating value of 3700 Btu/lb. The 50% moisture content value was used because even with chip drying components being added to the biomass system, the heat energy needed to dry the chips will come from the boiler itself, and this lower heating value takes into account this loss of efficiency of the plant, even if the chips fed into the boiler are at a lower moisture content.

8.4 Additional Energy Costs

Electrical energy consumption is projected to increase with the installation of the wood fired boiler. Equipment with electric motors include conveyors, augers, a compressor, and the heating hot water system pumps. The cash flow analysis accounts for the additional electrical energy consumption and reduces the annual savings associated with using the wood fired boiler plant

rather than the fuel oil boilers. The power use is based on historical data from a wood fired boiler plant in Darby, Montana and estimated heating system pump use.

8.5 Maintenance Costs

Based on discussions with other biomass system users, system manufacturers, and estimates of operator time required, additional operation and maintenance time on average of 5 hours per week were assumed. The cost of this over a 40 week operation period at \$20/hour was used for the analysis. In addition, experience has shown that the first two heating seasons have extra maintenance time as the system “bugs” are worked out and the maintenance staff learns the system. The analysis includes an additional 3 hours per week for the first two years to account for this learning curve. Since an electrostatic precipitator is assumed to be used, and additional 1 hour per week of maintenance was added to the analysis for this.

8.6 Inflation Assumptions

The O&M inflation rate was assumed to be 2%. The escalation rate for fuel oil and electricity was assumed to be 6%. Recent price volatility has made projections difficult. DOE now predicts a slight plateau and a long term escalation rates between 3% and 11%. Fuel cost escalation for wood based fuels was estimated at 3% annually. 3.0% was used for the Net Present Value (NPV) discount rate. Any options which included a financing component assumed interest rates of 5.0% for a term of 10 years. The principle and interest payments are based on single annual payments, resulting in slightly higher payments than those associated with a similar loan with monthly payments.

9.0 EVALUATION OF OPTIONS

9.1 Evaluation Metrics

The project was evaluated using a 30-year cash flow analysis. Net Present Value (NPV) at year 20 and year 30 was calculated as was Accumulated Cash Flow (ACF) in year 30. The net present value is a calculation of the net present value of an investment by using a discount rate and a series of future payments (negative values) and income (positive values). The NPV is based on the net annual cash flow series. The year the ACF equaled the capital cost was also calculated. Accumulated Cash Flow should also be considered an avoided cost rather than a pure savings because the savings are usually not allowed to accumulate.

9.2 Evaluation Summary

The table below summarizes the results of this assessment.

Table 6 — Economic Summary

| Option | Project Cost | Year 1 Operating Savings | NPV 30 yr at 3% | NPV 20 yr at 3% | ACF YR 30 | YR ACF=PC |
|--|--------------|--------------------------|-----------------|-----------------|-------------|-----------|
| Option A.1A Main Campus | \$2,673,000 | \$22,821 | \$2,335,846 | \$1,116,128 | \$4,274,093 | 25 |
| Option A.1.B Campus and Boiler Plant Location B | \$2,770,000 | \$22,821 | \$2,335,846 | \$1,116,128 | \$4,274,093 | 26 |
| Option A.1.C Adding Sewer Plant to Campus and Boiler Plant Location C | \$3,196,000 | \$17,710 | \$2,284,993 | \$1,055,333 | \$4,218,911 | 27 |
| Option A.2A Campus Less Vocational Education | \$2,549,000 | \$21,621 | \$2,250,020 | \$1,072,870 | \$4,119,428 | 25 |
| Option A.3A School Building Only Less Vocational Education | \$2,289,000 | \$17,098 | \$1,926,455 | \$909,790 | \$3,536,340 | 26 |
| Option A.4A Adding A Larger Load Such as DOT to Campus | \$3,196,000 | \$30,570 | \$3,204,906 | \$1,518,980 | \$5,876,662 | 24 |
| Option B.1 Campus with Pellet Boiler and Boiler Plant Location A | \$2,258,000 | -\$25,562 | \$926,646 | \$176,661 | \$1,972,273 | >30 |

The strongest option appears to be A.1A, the main campus with the new boiler plant located in location A (off of 5th Ave.). This option has the best 30 year NPV and 30 year ACF (dismissing Option A.4A – see discussion below). Detailed economic summary sheets for each of these options can be found in Appendix D.

Options A.1B and A.1C looked at alternate locations for the boiler plant. The capital cost increased for A.1B because larger pipe ran longer distances and since there was no additional fuel oil saved, the economics deteriorated. Option A.1C had increased capital cost from the need to directional drill under the Haines Highway, longer runs of large pipe, and also because new

pipng had to be installed in the Sewage Treatment Plant. Even though addition fuel oil was saved from the Sewage Treatment Plant, it was not enough to offset the increased capital cost and the economics also deteriorated.

Options A.2A and A.3A looked at ways to reduce the project costs by eliminating some of the integration work. Option A.2A reduced the capital cost by not connecting to the vocational education building, and Option A.3A was the lowest project cost for chip systems because all integration was eliminated except for the school alone (the largest fuel oil user). In both cases, however, even though the capital costs were reduced, there was also an associated reduction in fuel oil savings and the economics did not improve.

Option A.4A was created to see if adding a theoretical large nearby fuel oil consumer would be beneficial. No particular user was targeted, although the DOT site may be a possibility. The costs for this are very conceptual (because it is a theoretical user) and it was assumed that 58,500 gallons of fuel oil was displaced (compared to 37,924 gallons in A.1A). The additional capital cost offset the larger savings and the economics only slightly improved.

Option B.1 looked at a pellet boiler plant in location A. This option had the lowest capital cost because the building size was reduced significantly because a silo replaced the chip storage area and the pellet boiler system is cheaper than a chip system. However, with the current estimated price for pellets delivered to Haines, there is no fuel cost savings. In fact, at this time it will cost more to burn pellets than fuel oil, therefore, this option is not currently economically viable.

9.3 Sensitivity Analysis

Additional analysis was performed on Option A.1A to determine the sensitivity to varying some of the economic factors. The first factors adjusted were the fuel oil and electricity inflation rate and the wood fuel cost. The fuel oil unit cost was then varied. Finally the project cost was adjusted. A table summarizing the results of the sensitivity analysis can be found in Appendix D.

9.3.1 Fuel Oil and Electricity Inflation Rate and Wood Fuel Cost

The wood fuel cost was evaluated at \$65/ton, \$75/ton and \$85/ton. When the wood fuel cost was varied, the effect was minimal. The NPV and ACF decreased approximately 10% per for every increase of \$10 per ton. The fuel oil and electricity inflation rate was evaluated at 5%, 6%, 8%

and 11%, basically spanning the range DOE has estimated for long term inflation on fuel oil. Varying the fuel oil and electricity inflation rate had a significant effect. The NPV and ACF increased between 35% and 40% for each percent increase in fuel oil inflation rate. This factor had the greatest single effect on the economics.

9.3.2 Fuel Oil Unit Cost

The fuel oil unit cost was evaluated at \$3.25, \$3.75, \$4.25, and \$5.00 per gallon. Varying the fuel oil unit cost had a moderate effect. The NPV and ACF increased approximately 25% for each 15% increase in fuel oil unit cost.

9.3.3 Project Cost

The project cost was evaluated at 90%, 80%, and 70% of the estimated base cost and also at \$1,400,000 and \$1,000,000. Varying the project cost only affected the simple payback and the year in which ACF equaled the project cost and these changes had a minimal effect. This analysis indicates the project begins to become a strong project if the project costs can be reduced at least 30% (the NPV is 25% greater than the project cost at this point, although the year in which ACF equaled the project cost was still over 20 years (22)).

10.0 CONCLUSION

With the present fuel oil price per gallon, consumption of fuel oil, and the high capital costs of integrating a biomass heating system into multiple boiler rooms, this project is challenged.

Currently the 30 year NPV of the annual savings does not equal the initial project cost and the ACF equals the 30 year NPV in year 25. The project economics are greatly affected by fuel oil cost and inflation. If fuel oil approaches \$3.75 per gallon, or the long term fuel oil cost inflation rate approaches 8% (as opposed to 6%), then the project becomes much more viable. If additional fuel oil loads can be added to the system (for a total displacement of at least 65,000 gallons) with reasonable integration costs, the project becomes more viable. Recent projects in the western continental US of similar scope of integration have had better economics. This is mainly due to the fact that the cost of construction is less in the lower 48 (nearly 30%), and also because chipped wood fuel can be purchased between \$40 and \$60 per ton.

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11.0 FIGURES

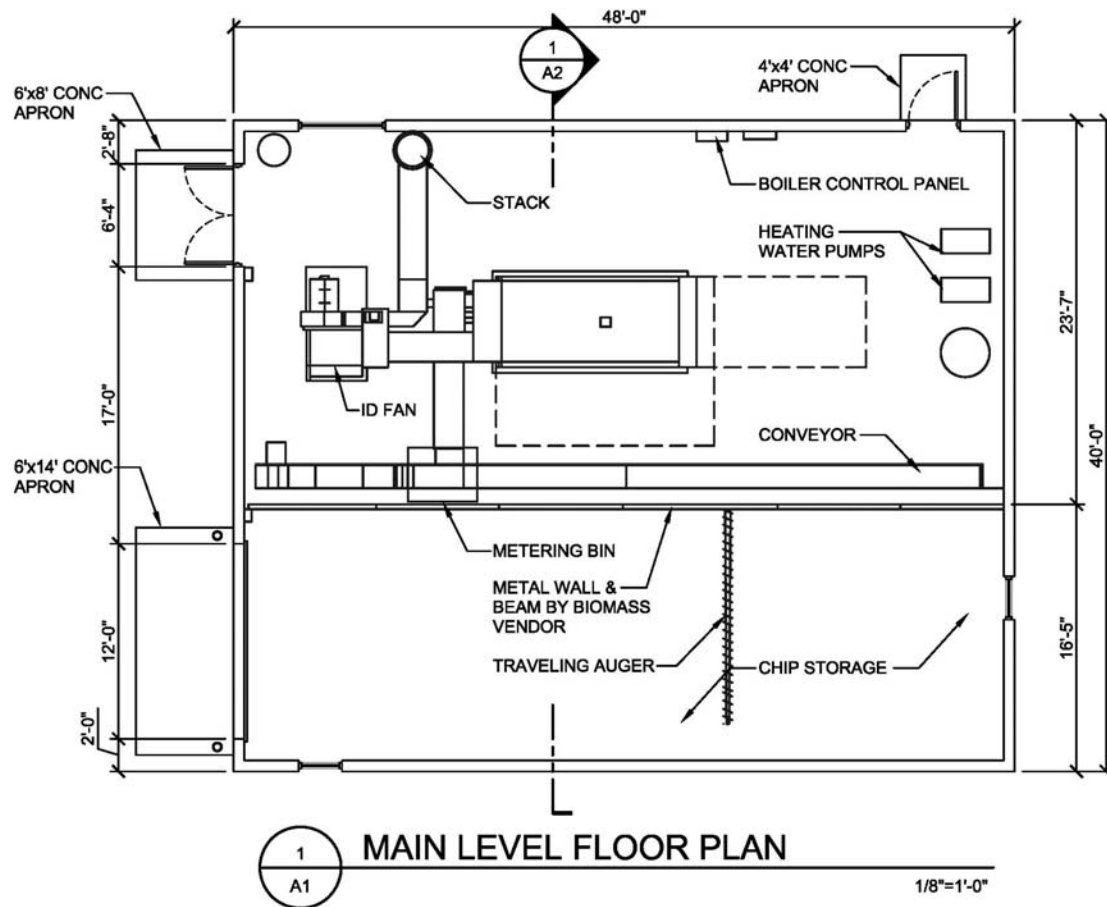


Figure 2 — Floor plan of Central Wood Heat Building

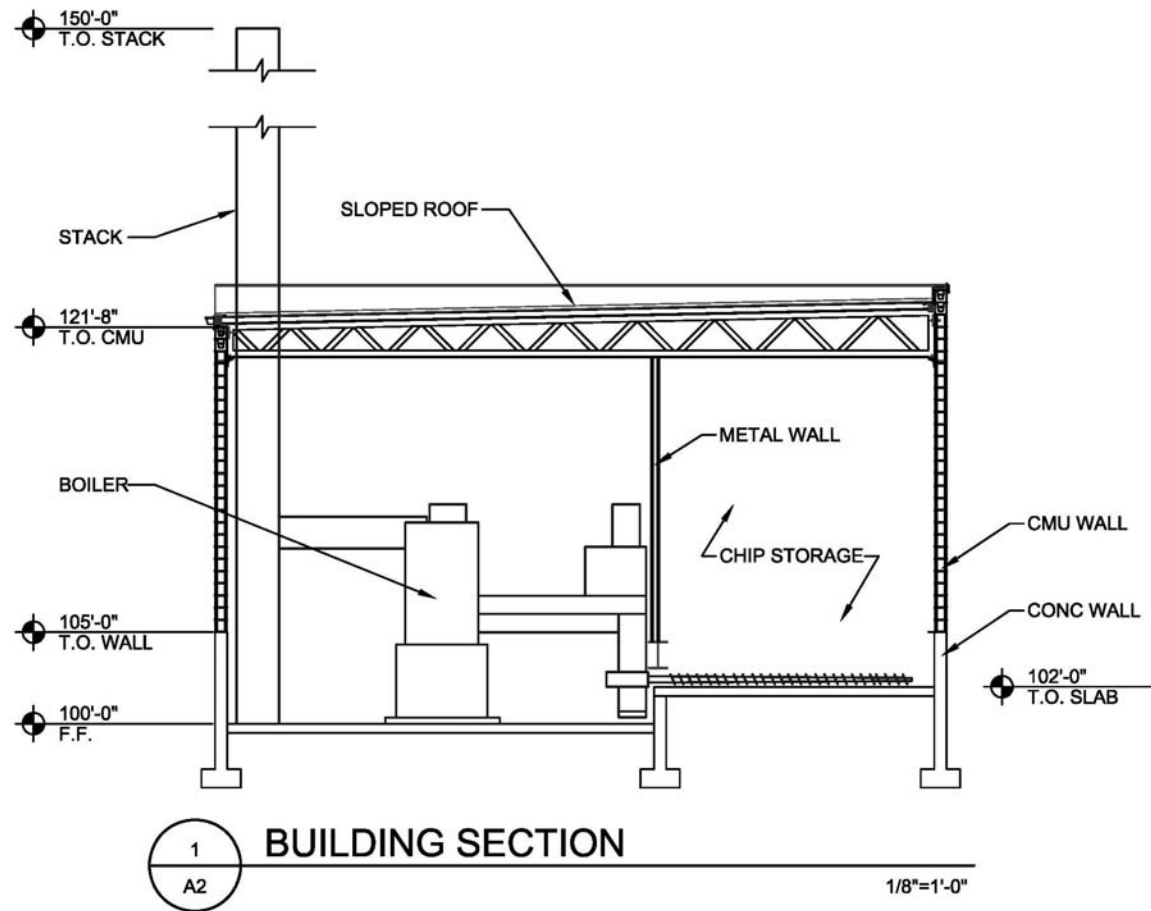


Figure 3 — Elevation of Central Wood Heat Building

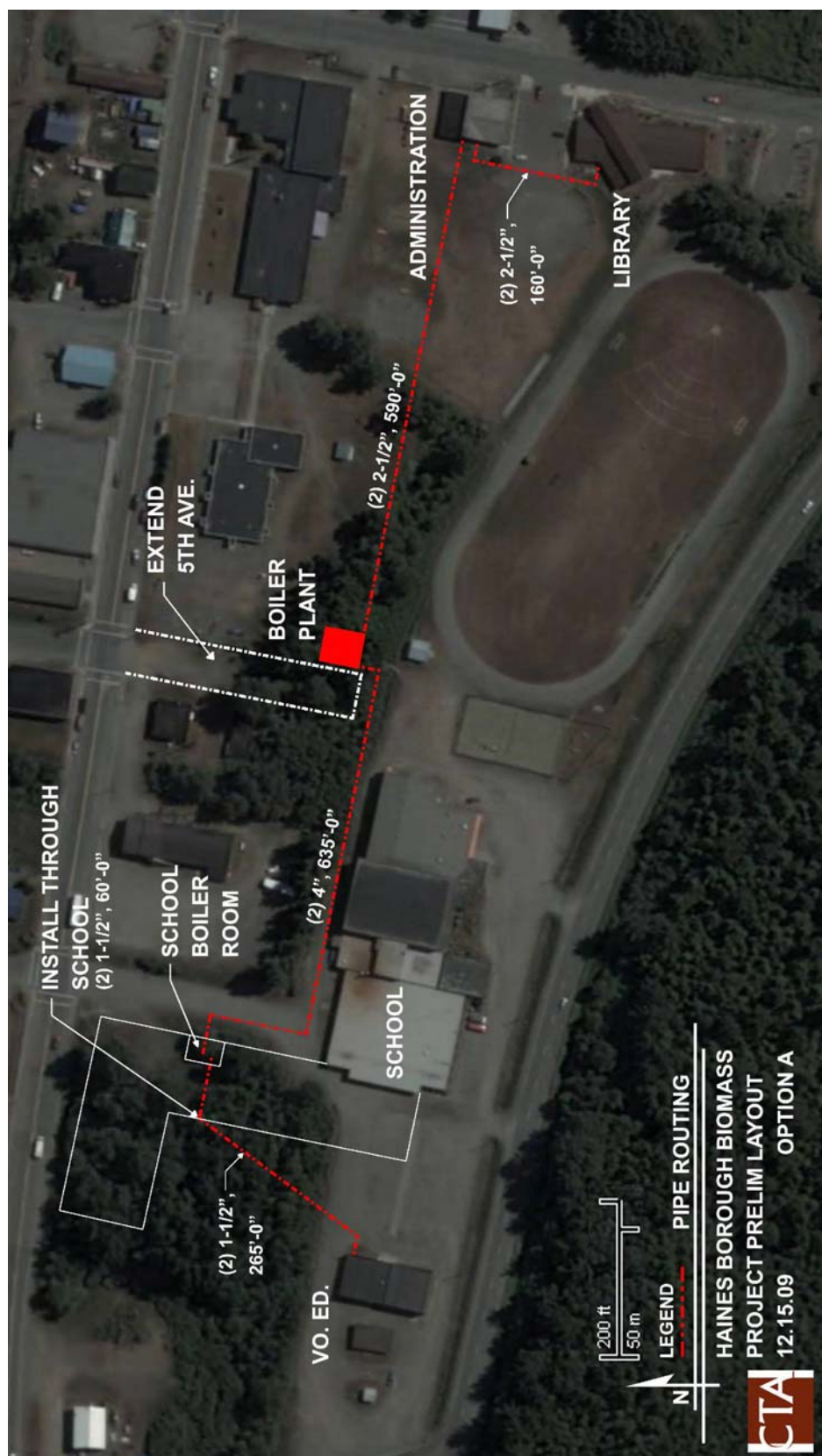


Figure 4 — Heat system preliminary layout for option A

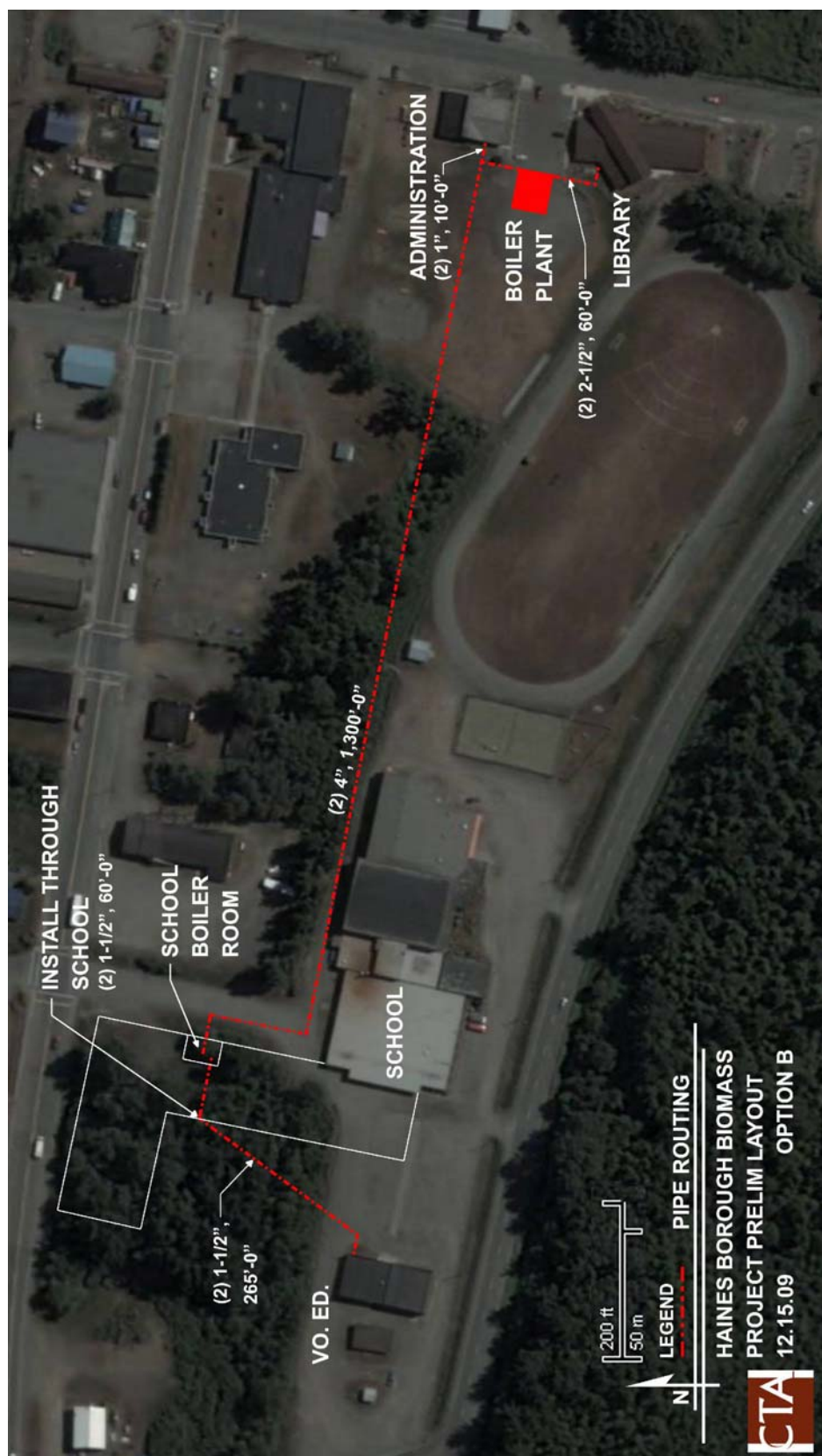


Figure 5 — Heat system preliminary layout for option B

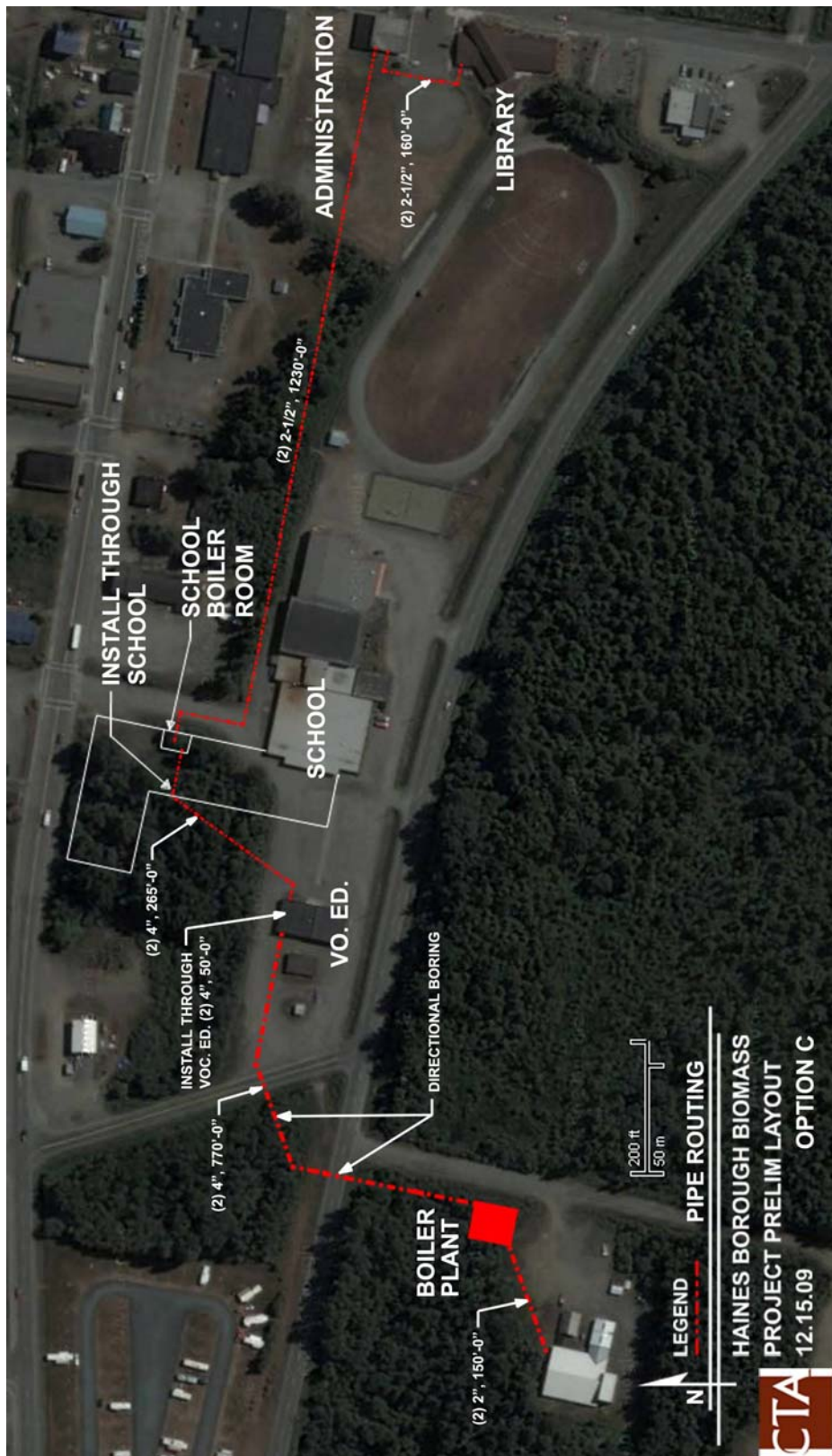


Figure 6 — Heat system preliminary layout for option C